

Selecting, Exposing, and Defining a Soil Characterization Site



A. Selecting a Soil Characterization Site

Soil characterization measurements are taken for different reasons, including,

- supporting the interpretation of soil moisture and temperature measurements;
- complementing and extending land cover mapping; and
- developing soil maps of a region.

For GLOBE, most schools focus on the first of these objectives, and for this a teacher must choose a site that is close to the school's Soil Moisture Study Site or to their Atmosphere Study Site where students are measuring soil temperature. These sites may be collocated. If students will be doing the *Soil Characterization Protocol* together with the *Land Cover Site Protocol*, then a place should be chosen within the Land Cover Site that is representative of the site and where students can dig with minimum disturbance to the site and its long-lived vegetation (e.g., trees and perennial shrubs). If students will be developing a soil map of their region (e.g., watershed) or their GLOBE Study Site, sites should be chosen that represent different soil formation situations. For instance, students may wish to sample soil at the top, side, and bottom of a hill, or next to a stream or lake and upland on both sides of the water body. Comparisons of soil characteristics from two or three nearby sites can provide the basis for interesting inquiry or student research projects.

No matter which site location is chosen, the following steps should be considered:

1. The site needs to be safe for digging. Teachers and students should check with local utility companies and school maintenance staff to be sure that they do not dig into or disturb utility cables, water, sewer, or natural gas pipes, or sprinkler irrigation systems.
2. A site should be chosen that looks similar to the rest of the landscape and, if possible, is covered with natural vegetation. Lawns or other managed landscapes are acceptable if this is the cover that is located at the atmosphere and soil moisture and temperature measurement sites.
3. The site chosen should be relatively undisturbed. It should be at least 3 meters from buildings, roads, paths, playing fields, or other places where soils may have been compacted or disturbed by construction.
4. The site should be oriented so that the sun shines on the soil profile at the time students carry out the soil characterization measurements to ensure the soil characteristics are clear for both naked-eye observations and photography. In some cases, sites are chosen where sunlight does not strike the soil profile (e.g., existing exposed profiles or pits dug under tree canopies). In these cases, students will need to take samples to a place where there is sunlight to determine the soil color.



B. Exposing the Profile of a Soil Characterization Site

There are three options for exposing the soil at a Soil Characterization Site:

1. **Pit Method:** Students dig a soil pit approximately 1 meter deep (or until an impenetrable layer is reached) and as big around as is necessary to easily observe all of the soil horizons from the bottom to the top of the pit (approximately 1.5 x 1.5 m wide). In some situations, students may be able to perform the soil characterization measurements at a site where the soil profile has already been exposed through human or natural action (e.g., a road cut or the side of a ravine). In these instances, teachers need to make sure that the site is safe for students and there is no objection to them scraping the surface soil away to expose a fresh soil face.
2. **Auger Method:** Students use a soil auger or probe to remove soil samples to a depth of 1 meter.
3. **Near Surface Method:** Students use a garden trowel or shovel to remove soil samples. Students dig to a depth of at least 10 cm. If deeper digging is possible, students should dig up to 1 meter.

Note: Some steps of the *Soil Characterization Field Measurement Protocol* vary depending upon which method students chose to expose their site.



C. Defining a Soil Characterization Site

After students have selected and exposed a soil characterization site, they define the site according to a number of factors. They record their descriptions in their GLOBE Science Notebooks and onto the *Soil Characterization Site Definition Sheet*. This information is important for students and scientists to understand the way the Earth system is functioning at that location. The following factors are defined:

Latitude, Longitude and Elevation: The location of the site is determined according to lines of latitude and longitude and elevation above sea level. These coordinates are established using a Global Positioning System (GPS) receiver.

Aspect: The aspect is the direction of the steepest slope across the exposed soil site. This information indicates how the sun will influence soil properties. In the Northern Hemisphere, south facing slopes face the sun and tend to be drier and more weathered, while north facing slopes tend to be cooler. The opposite relationship occurs in the Southern Hemisphere.

Site Exposure Method: The approach used by students to expose and study the soil is identified as the pit method, auger method or near surface method.

Site Location: Soil characterization data is important for interpreting soil moisture and temperature measurements, atmospheric measurements and land cover measurements. The location of the soil characterization site relative to these other measurement sites needs to be defined so that data collected for these measurements can be correlated.

Landscape Position and Slope: The landscape position describes the contours of the land at the soil characterization site. The slope describes the angle at which the land of the site is angled and is measured in degrees. These descriptors indicate the processes and inputs that helped form the soil at the site. For example, this information determines whether the soil was formed by erosion or deposition. It can also establish whether

rain falling on the site will run-off, settle into a pond, or infiltrate into the ground.

Cover Type: Cover type is a description of the matter on the surface of the soil. If nothing is covering the soil then it is described as bare soil. Otherwise, the matter covering the soil can be described as rocks, grass, shrubs, trees or other.

Parent Material: The matter from which the soil develops is called the parent material. Identifying the parent material of the soil helps to interpret its texture, mineralogy, weathering rate, and fertility.

Land Use: The manner in which the land is used at the soil site can be defined as urban, agricultural, recreational, wilderness or other. Land use can have a formidable effect on soil formation and help to interpret and explain a soil's properties and development.

Distance from Major Features and Other Distinguishing Characteristics of the Site: Other information or metadata about the site that does not fit into any of the above categories should also be recorded.

Suggestions for Digging and Managing a Soil Characterization Site

Pit Method

- Digging is much easier when the soil is moist. If possible, plan digging shortly after a rain.
- As soil is removed from the pit, place it carefully in piles representing each of the natural layers as they occur in the profile.
- The removed soil can be put on a tarp to make clean up of the site easier.
- Cover piles of removed soil with plastic to prevent them from eroding away.
- Request help from parents, school personnel, students, or other volunteers.
- Contact a local USDA Natural Resources Conservation Service office (in the US), or other agricultural organization or University. Many times, a soil scientist or other professional will be willing to assist you in digging a pit and helping describe the characteristics of the soil profile.

- Surround the pit with a fence and mark it with flags to alert people to where it is.
- Cover the pit with boards or some other material to keep animals or debris from falling in when it is not being used.
- When finished with the soil characterization measurements, the horizons need to be replaced into the soil pit in reverse order (last one out should be first one back in).
- Plan to plant a tree at the soil sampling site location. Once the pit for the tree has been dug, identify the horizons in the profile, conduct the soil characterization measurements, collect laboratory samples and then plant the tree in the soil pit.

Auger Method

- Identify an area where four auger holes can be dug and where the soil profiles are similar.
- A Dutch auger, as described in the *Toolkit* is best for most soil, especially for rocky, clayey, and dense soils.
- A sand auger is needed if the soil is very sandy in texture. In some places, the soil is mostly peat and a special peat auger should be used.
- A bucket auger may be better for dry, desert soils.
- Students need a horizontal surface (e.g., the ground) on which to display the vertical soil profile.
- Spread a plastic sheet, tarp, board, or other surface on the ground next to where the auger holes are dug for laying out the profile.
- A rain gutter trough, one meter in length, can be used to lay out the augered soil sample. This allows for the sample to be labeled, transported and stored.
- Assemble a profile of the top 1 meter of soil by removing successive samples from the ground with the auger and laying them end-to-end.

Near Surface Method

- Use this method if digging deeper is not possible.



Questions for Guiding Students

The following questions can be used to engage and guide students in selecting, exposing and defining their soil characterization site:

Is the soil moist or dry, difficult or easy to dig, warm or cool?

Can you distinguish differences in color or other soil properties as the soil is being removed?

What is the parent material from which the soil was formed? Was it bedrock? If so, look for rocks on the surface to tell you something about the kind of rock. Could your soil have been deposited by water or wind, by a glacier or volcano?

What are the types of plants and animals you might find in the soil and the general area around your site? Include small organisms in the soil such as earthworms or ants.

Where in the landscape is your soil? Is it on a hilltop, slope, or bottom of a hill? Is it next to a stream or on a flat plain? On what kind of landform is it found?

What is the general climate at your soil site? Is it sunny, shaded, hot, cold, moist, dry?

What is the recent land use in this area? Has it been stable for a long time, or has it been plowed, its trees cut, used for construction, or undergone some other disturbance recently?



Questions for Further Investigation

How has the history of this area (human activity) affected this soil?

How has land cover affected this soil?

How has local climate (micro climate) affected this soil?

How has this soil affected local human history?

How has location in the landscape influenced this soil?

How would soils with different slopes differ from each other?

How does aspect affect soil properties?

Soil Characterization Site Exposure – Pit Method

Field Guide

Task

To dig a soil pit that exposes a soil profile for soil characterization measurements and to define the site

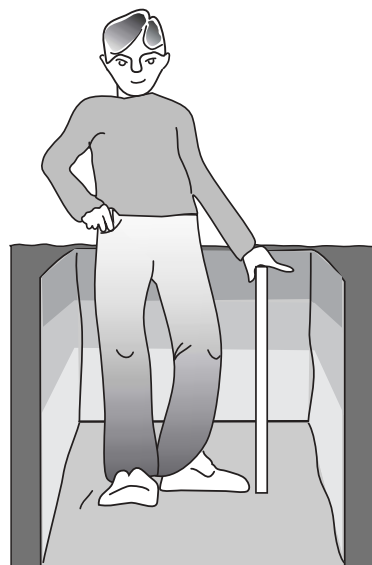
What You Need

- | | |
|---|--|
| <input type="checkbox"/> Shovels, trowels, backhoe or other digging implements | <input type="checkbox"/> Help with digging! |
| <input type="checkbox"/> Flags for marking the site | <input type="checkbox"/> Clinometer |
| <input type="checkbox"/> Fence, boards, or other protection to surround and cover a pit when not in use | <input type="checkbox"/> Local information about your site |
| <input type="checkbox"/> Plastic tarp to cover piles of soil | <input type="checkbox"/> Compass |
| <input type="checkbox"/> Soil Characterization Site Definition Sheet | <input type="checkbox"/> GPS receiver |

In the Field

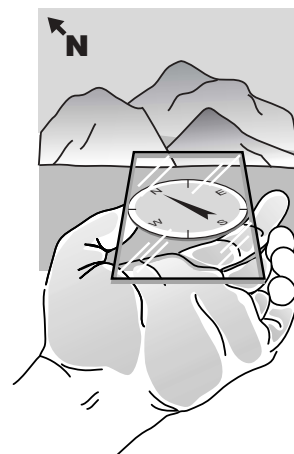
Exposing the Soil Profile

1. Identify a location where you can dig a soil pit.
2. Dig the soil pit approximately 1 meter deep (or until a hard layer is reached). Make the pit as big around as is necessary to easily observe all of the soil horizons from the bottom to the top of the pit (approximately 1.5 m x 1.5 m).
3. As soil is removed from the pit, place it carefully on a tarp in piles representing each of the natural layers of the profile. The horizons need to be replaced in reverse order (last out, first in) once you are finished using the pit. Cover the pile of soil with plastic to prevent the soil from blowing or washing away.
4. Surround the pit with a fence and mark it with flags to alert people of its location.
5. Cover the pit with boards or some other material to keep animals or debris from falling in when it is not being used.



Defining the Soil Characterization Site

1. Give the site a name or number (e.g., SCS-01). Record this on the *Soil Characterization Site Definition Sheet*.
2. Measure the latitude, longitude, and elevation of the site using the *GPS Protocol*. Record this information on the *Site Definition Sheet*.
3. Identify the steepest slope that crosses the area of exposed soil.
 - a. Two students (A and B) are needed whose eyes are at about the same height to measure the slope. One other student (C) is needed to be the “reader” and “recorder”.
 - b. Student A holds the clinometer and stands down slope while student B walks to the opposite side of the hole. Students A and B should be about 30 m apart (or as far apart as easily possible). Student C should stand next to student A.
 - c. Looking through the clinometer, Student A sites the eye level of Student B. Student C reads the angle of slope on the clinometer in degrees, and records this reading on the *Site Definition Sheet*.
4. Identify the aspect of the steepest slope:
 - a. Face up the steepest slope across the exposed soil area.
 - b. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.
 - c. Read the number on the edge of the compass housing (which can range from 0 to 360).
 - d. Record this value on the *Site Definition Sheet*.
5. Record “Pit” as the method used to expose the soil profile.
6. Record whether the site is on or off school grounds.
7. Record a description of the site location. (Near the Soil Moisture Study Site, Near the Soil Moisture and Atmospheric Study Sites, Near the Atmosphere Study Site, In the Biology Study Site, Other)
8. Describe and record the position on the landscape where the site is found. (Summit, Side Slope, Depression, Large Flat Area, Streambank)
9. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).
10. Describe and record the type of parent material from which the soil was formed at the site (Bedrock, Organic Material, Construction Material, Marine, Lake, Stream, Wind, Glaciers, Volcanoes, or Loose materials on slope moved by gravity).
11. Describe and record the land use at the site (urban, agricultural, recreation, wilderness, other)
12. Measure and record the distance (up to 50 m) of the site from major features (e.g., buildings, power poles, roads, etc.).
13. Describe and record any other distinguishing characteristics of this site.



Soil Characterization Site Exposure – Auger Method Field Guide

Task

Use an auger to expose a soil profile for characterization measurements and define the site.

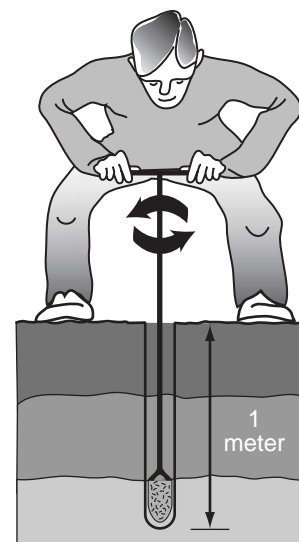
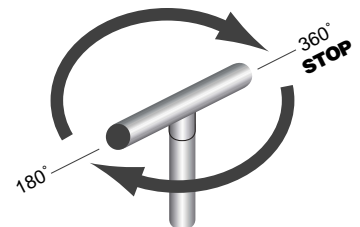
What You Need

- | | |
|---------------------------------------|--|
| <input type="checkbox"/> Soil auger | <input type="checkbox"/> Meter Stick |
| <input type="checkbox"/> Clinometer | <input type="checkbox"/> Local information about your site |
| <input type="checkbox"/> Compass | <input type="checkbox"/> Plastic bags to lay out the soil profile |
| <input type="checkbox"/> GPS receiver | <input type="checkbox"/> Soil Characterization Site Definition Sheet |

In the Field

Exposing the Soil Profile

1. Identify a location where an auger can be used to expose a soil profile.
2. Spread a plastic sheet, tarp, board, etc. on the ground next to where the first hole will be dug and where the sun will shine on the profile.
3. Remove the surface vegetation.
4. Place the auger at the top of the soil and turn the auger one complete revolution (360°) to dig into the ground. Do not turn the auger more than one complete circle (360°) to prevent the soil from being compacted.
5. Remove the auger with the sample from the hole and hold the auger over the plastic sheet, etc.
6. Transfer the sample from the auger to the plastic sheet, etc. as gently as possible. Place the top of this sample just below the bottom of the previous sample.
7. Measure the depth of the hole. Adjust the sample on the plastic bag, tarp, or board so that its bottom is no further from the top of the soil profile than this depth.
8. Record the depths at which there are differences in soil properties. (This will help to determine the top and bottom depths of the horizons for soil characterization.)



Defining the Soil Characterization Site

1. Give the site a name or number (e.g., SCS-01). Record this on the *Soil Characterization Site Definition Sheet*.
2. Measure the latitude, longitude, and elevation of the site using the *GPS Protocol*. Record this information on the *Site Definition Sheet*.
3. Identify the steepest slope that crosses the area of exposed soil.
 - a. Two students (A and B) are needed whose eyes are at about the same height to measure the slope. One other student (C) is needed to be the “reader” and “recorder”.
 - b. Student A holds the clinometer and stands down slope while student B walks to the opposite side of the hole. Students A and B should be about 30 m apart (or as far apart as easily possible). Student C should stand next to student A.
 - c. Looking through the clinometer, Student A sites the eye level of Student B. Student C reads the angle of slope on the clinometer in degrees, and records this reading on the *Site Definition Sheet*.
4. Identify the aspect of the steepest slope:
 - a. Face up the steepest slope across the exposed soil area.
 - b. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.
 - c. Read the number on the edge of the compass housing (which can range from 0 to 360).
 - d. Record this value on the *Site Definition Sheet*.
5. Record “Auger” as the method used to expose the soil profile.
6. Record whether the site is on or off school grounds.
7. Record a description of the site location. (Near the Soil Moisture Study Site, Near the Soil Moisture and Atmospheric Study Sites, Near the Atmosphere Study Site, In the Biology Study Site, Other)
8. Describe and record the position on the landscape where the site is found. (Summit, Side Slope, Depression, Large Flat Area, Streambank)
9. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).
10. Describe and record the type of parent material from which the soil was formed at the site (Bedrock, Organic Material, Construction Material, Marine, Lake, Stream, Wind, Glaciers, Volcanoes, or Loose materials on slope moved by gravity).
11. Describe and record the land use at the site (urban, agricultural, recreation, wilderness, other)
12. Measure and record the distance (up to 50 m) of the site from major features (e.g., buildings, power poles, roads, etc.).
13. Describe and record any other distinguishing characteristics of this site.



Soil Characterization Site Exposure – Near Surface Method

Field Guide

Task

Expose the top 10 cm of soil for soil characterization measurements and define the site.

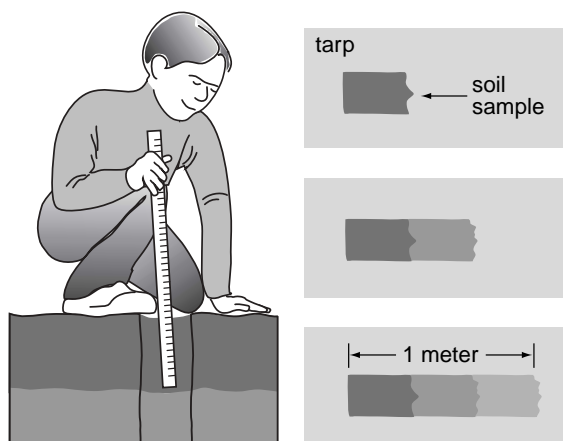
What You Need

- | | |
|--|---|
| <input type="checkbox"/> Meter Stick or metric ruler | <input type="checkbox"/> Clinometer |
| <input type="checkbox"/> Local information about your site | <input type="checkbox"/> Compass |
| <input type="checkbox"/> GPS receiver | <input type="checkbox"/> <i>Soil Characterization Site Definition Sheet</i> |

In the Field

Exposing the Soil Profile

1. Identify a location where the surface of the soil can be exposed.
2. Remove the surface vegetation.
3. Use a garden trowel or shovel to carefully remove the top 10 cm of soil from a small area and set it on the ground.
4. Treat this sample as a horizon.



Defining the Soil Characterization Site

1. Give the site a name or number (e.g., SCS-01). Record this on the *Soil Characterization Site Definition Sheet*.
2. Measure the latitude, longitude, and elevation of the site using the *GPS Protocol*. Record this information on the *Site Definition Sheet*.
3. Identify the steepest slope that crosses the area of exposed soil.
 - a. Two students (A and B) are needed whose eyes are at about the same height to measure the slope. One other student (C) is needed to be the “reader” and “recorder”.
 - b. Student A holds the clinometer and stands down slope while student B walks to the opposite side of the hole. Students A and B should be about 30 m apart (or as far apart as easily possible). Student C should stand next to student A.
 - c. Looking through the clinometer, Student A sites the eye level of Student B. Student C reads the angle of slope on the clinometer in degrees, and records this reading on the *Site Definition Sheet*.

4. Identify the aspect of the steepest slope:
 - a. Face up the steepest slope across the exposed soil area.
 - b. Hold the compass in your hand so that the red arrow is lined up with the North position on the compass.
 - c. Read the number on the edge of the compass housing (which can range from 0 to 360).
 - d. Record this value on the *Site Definition Sheet*.
5. Record “Near Surface” as the method used to expose the soil profile.
6. Record whether the site is on or off school grounds.
7. Record a description of the site location. (Near the Soil Moisture Study Site, Near the Soil Moisture and Atmospheric Study Sites, Near the Atmosphere Study Site, In the Biology Study Site, Other)
8. Describe and record the position on the landscape where the site is found. (Summit, Side Slope, Depression, Large Flat Area, Streambank)
9. Describe and record the cover type of the site (Bare Soil, Rocks, Grass, Shrubs, Trees, or Other).
10. Describe and record the type of parent material from which the soil was formed at the site (Bedrock, Organic Material, Construction Material, Marine, Lake, Stream, Wind, Glaciers, Volcanoes, or Loose materials on slope moved by gravity).
11. Describe and record the land use at the site (urban, agricultural, recreation, wilderness, other)
12. Measure and record the distance (up to 50 m) of the site from major features (e.g., buildings, power poles, roads, etc.).
13. Describe and record any other distinguishing characteristics of this site.

